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CONTENTS

PEDAGOGY

ECONOMICS

МАЗМҰНЫ

ПЕДАГОГИКА

ЭКОНОМИКА

СОДЕРЖАНИЕ

ПЕДАГОГИКА

ЭКОНОМИКА

SCIENTIFIC JOURNAL OF PEDAGOGY AND ECONOMICS
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METHODS OF USING VIRTUAL LABORATORIES IN ROBOTICS TRAINING

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Abstract. In robotics training, numerous tools are used, but the high cost of equipment often prevents students from completing tasks during lessons. Building a robot also requires significant time, accuracy, and responsibility. Recently, virtual laboratories have been introduced as an effective way to address these challenges. They motivate students, enhance creativity and interest in learning, and make laboratory work more accessible and complete. Platforms such as TinkerCAD provide free, easy-to-use environments that allow students to perform experiments and develop practical skills. The purpose of this study is to identify the opportunities and needs associated with using virtual laboratories in teaching robotics. The objectives are to analyze the effectiveness of online platforms, demonstrate methods of virtual robot assembly, and determine teachers' needs regarding the use of robotics in education. The study examines the application of TinkerCAD in robot construction and finds it effective for teaching robotics through modeling. An example task-simulating a traffic light LED system using Arduino in TinkerCAD-illustrates the platform's educational potential. Furthermore, a survey among university teachers revealed their positive attitude toward virtual laboratories and the need for their wider use in robotics education. The findings show that the dynamic and interactive nature of virtual laboratories helps develop students' creative thinking, problem-solving skills, and motivation to complete tasks. The research employed surveys, analysis, synthesis, and data interpretation as key methods.

Keywords: virtual laboratories, robotics, tasks, students

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РОБОТОТЕХНИКАНЫ ОҚЫТУДА ВИРТУАЛДЫ ЗЕРТХАНАЛАРДЫ ҚОЛДАНУ ӘДІСТЕРІ

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Аннотация. Робототехниканы оқытуда көптеген құралдар пайдаланылады, алайда олардың толық жиынтығын қамтамасыз ету қымбат болғандықтан, кейбір тапсырмаларды орындау мүмкін болмай қалады. Робот құрастыру барысында білім алушыларға көп уақыт пен тиянақтылық, сондай-ақ жоғары жауапкершілік қажет. Соңғы жылдары білім беру үдерісіндегі осындай мәселелерді шешуге бағытталған виртуалды зертханалар тиімді шешімдердің бірі ретінде қарастырылуда. Олар студенттерді шабыттандырып, сабаққа қызығушылықты арттырады және зертханалық жұмыстарды қауіпсіз әрі қолжетімді форматта жүргізуге мүмкіндік береді. Зерттеудің өзектілігі – виртуалды зертханаларды робототехниканы оқыту процесінде қолдану мүмкіндіктерін айқындау және олардың білім алушылардың танымдық белсенділігіне әсерін зерттеу. Зерттеудің мақсаты – робототехниканы оқытуда виртуалды зертханаларды қолданудың тиімділігін бағалау, олардың оқу процесін жетілдірудегі рөлін анықтау. Зерттеу міндеттері: онлайн платформалар ішінен робототехниканы үйретуге тиімді виртуалды зертханаларды іріктеу; робот құрастыруды модельдеу процесінде оларды қолдану әдістерін сипаттау; жоғары оқу орындары оқытушыларының пікірлері негізінде виртуалды зертханаларды қолдану қажеттілігін айқындау. Мақалада виртуалды зертханаларды робот құрастыру процесінде пайдалану әдістемесі қарастырылды. Онлайн платформаларды салыстырмалы талдау нәтижесінде Tinker Cad виртуалды зертханасының робототехниканы оқытуда тиімді екені анықталды. Tinker Cad платформасында Arduino негізінде бағдаршам жарық диодтарын жағу мысалы арқылы модельдеу әдісі түсіндірілді. Сонымен қатар, ЖОО оқытушылары арасында жүргізілген сауалнама нәтижелері ұсынылды. Сауалнама деректері Tinker Cad зертханасында орындалатын жұмыстардың тиімділігін және виртуалды зертханалардың динамикалық, интерактивті сипаты білім алушылардың шығармашылық қабілеттері мен тапсырма шешу дағдыларын дамытуға ықпал ететінін көрсетті. Зерттеу барысында сауалнама,

талдау, синтез және мәліметтерді интерпретациялау секілді жалпы ғылыми әдістер қолданылды.

Түйін сөздер: виртуалды зертханалар, робот техникалары, тапсырмалар, білім алушылар

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МЕТОДИКА ИСПОЛЬЗОВАНИЯ ВИРТУАЛЬНЫХ ЛАБОРАТОРИЙ В ОБУЧЕНИИ РОБОТОТЕХНИКЕ

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Аннотация. При обучении робототехнике используется большое количество робототехнических средств. Однако из-за высокой стоимости их полного оснащения выполнение всех практических заданий зачастую становится невозможным. Сборка роботов требует значительных временных затрат, аккуратности и ответственности со стороны обучающихся. Виртуальные лаборатории, которые в последние годы активно внедряются в образовательный процесс, способны решить часть этих проблем. Они повышают мотивацию и интерес студентов, делают занятия более интерактивными и позволяют полноценно выполнять лабораторные работы. Особенно эффективными оказались платформы Tinker Cad и ряд аналогичных ресурсов, отличающихся доступностью, простотой использования и бесплатным доступом. Актуальность исследования заключается в необходимости определения возможностей применения виртуальных лабораторий в обучении робототехнике. Цель исследования — выявить возможности и педагогический потенциал виртуальных лабораторий при обучении робототехнике. Задачи исследования: Проанализировать эффективность виртуальных лабораторий среди различных онлайн-платформ. Продемонстрировать методы их применения в процессе моделирования и сборки роботов. Определить потребность в использовании виртуальных лабораторий в обучении робототехнике среди преподавателей вузов. В статье рассмотрено использование виртуальных лабораторий при конструировании роботов. В ходе сравнительного анализа онлайн-платформ установлено, что виртуальная лаборатория Tinker Cad является наиболее эффективной для обучения робототехнике. Приведен пример применения

этой платформы для моделирования сборки робота: рассмотрено задание по управлению светодиодами светофора с помощью контроллера Arduino в среде Tinker Cad. Кроме того, представлены результаты опроса преподавателей, проведенного с целью определения потребностей и возможностей применения виртуальных лабораторий в обучении робототехнике. Согласно результатам, эффективность работ, выполняемых в Tinker Cad, подтверждена практическими примерами. Динамичный и интерактивный характер виртуальных лабораторий способствует развитию творческих способностей и навыков решения задач у обучающихся. В ходе исследования применялись общенаучные методы — анкетирование, анализ, синтез и интерпретация данных.

Ключевые слова: виртуальные лаборатории, робототехника, задания, обучающиеся

Introduction. Robotics is one of the main directions of scientific and technological progress. Currently, the field of application of robotic systems is constantly expanding. This is primarily due to the advent of highly integrated electronic circuits, their mass production and affordable prices. What used to require a lot of effort for development, repair and maintenance is now available in the form of microprocessors, microcontrollers, sensors. There are similar conditions in software - on the basis of many commercial and free software, software is created for motion control systems and modeling the operation of robots.

Secondly, this is due to the advent of powerful, affordable personal computers. Modeling of electronic and mechanical systems does not require the use of volumetric computing centers. The availability of a public means of communication in the form of a global computer network of the Internet makes it possible to exclude boundaries when scientists of various research groups interact with each other.

Thirdly, there is a strong incentive for the development of this area of science and technology, associated with the urgent need for a cheap, reliable, and simple labor force that can replace a person when performing heavy, responsible, or dangerous work. This direction can be called classic, but it is worth noting that recently great attention has been paid not only to specialized robots but also to autonomous multifunctional devices for everyday life and the service sector.

In recent years, robotics has changed our understanding of automation, artificial intelligence, and human-robot interaction. One of the innovative methods of stimulating and involving teachers in robotics was the use of virtual laboratories.

Research materials and methods. The use of robotic tools in robotics training can be expensive. On the other hand, there is a need for virtual laboratories to offer an alternative that breaks many of these barriers, providing a safe and cost-effective environment in which learners can learn the principles of robotics. Features of robotics virtual laboratories it is proposed to use virtual laboratories in teaching robotics to elementary school students. Scientific-theoretical and scientific-methodological justification of the use of virtual laboratories in teaching robotics to primary school students and improving its methodology, conducting practical experiments

in Computer Science for primary school students, scientific and methodological recommendations are given.

Currently, the «virtual» name has become one of the most common in our lives. The term «virtual» in Latin means «virtus» - truth. the concept of «virtuality» also entered education. Virtual education is not only distance learning through information technologies but also a process that broadly connects subjects and objects of education in the virtual space. Virtual education will be creating conditions for virtual learning and creating a virtual environment in the education space. The goal of virtual education is a tool to improve the personal and professional effectiveness of each person, aimed at the comprehensive development of the person. Education virtualization is manifested in the development of multimedia and telecommunications technologies in independent training, full-time, and part-time training, in social networks.

The use of robotics in robotics training can be costly. On the other hand, virtual labs offer an alternative that violates most of these barriers, providing a safe and cost-effective environment in which learners can learn the principles of robotics (Koshanova et al, 2024).

Ensures the quality of knowledge acquisition with the efficient use of resources, resources, and resources. Quality assurance is based on ICT efficiency (Bidaybekov et al, 2025).

Virtual learning is the most convenient tool for education and necessary for people with disabilities. The possibilities of virtual learning are endless and help overcome many obstacles. The virtual environment creates an artificial world that is transmitted to a person through feelings: vision, hearing, feeling, etc. People can interact with a 3D virtual environment, as well as manage objects and perform specific tasks (Bektemessov et al, 2025).

The use of virtual laboratories is a modern promising direction in education. The relevance of the introduction of virtual laboratories into educational practice depends, firstly, on information calls of time, and secondly, on the regulatory requirements for the organization of education at the level of basic and higher education.

Advantages of virtual labs over specific labs:

1) no need to purchase expensive equipment and reagents;

2) the possibility of modeling processes (finally impossible in laboratory conditions);

3) control over events occurring in time;

4) safety;

5) the possibility of using a virtual laboratory during distance learning;

6) self-education.

Performing laboratory work using virtual laboratories will allow students to independently study chemical phenomena and patterns, to verify the reliability of practical results. Of course, this practical activity of students is carried out under the guidance of a teacher. An important advantage of the virtual learning experiment is that the student can repeat this work many times, which contributes to a strong and deep absorption of the material (Pimentel et al, 2021; Raj et al, 2023).

Issues of teaching the subject of robotics are studied by a number of domestic scientists: M.Serik, G.Dimirovski N., Nurym considered issues of using interactive learning tools in teaching the subject of «Robotics» (Serik et al, 2023); Nurlybayev K.K. Development of creative abilities of teachers based on drawing up project work on training the course of robotics (Nurlybaev, 2018); Sh.T. Shekerbekova, M.I.Revshenova E.H. Zhabaevs discussed topical issues of training robotics at school (Shekerbekova et al, 2023); Baibusinova SHS, Kurmangalieva A.K. studied the use of robotics as a tool to stimulate students in the subjects of natural mathematics (Bajbusinova et al, 2019).

In connection with the latest events in the world and the country, the introduction of innovative distance learning technologies will contribute to improving the level of education. In addition, virtual lab work allows a student who has missed some topics to fill in the gaps regardless of the teacher's presence in the workplace. This type of laboratory work allows you to independently consider phenomena and objects classified as independent work. The use of an educational resource, such as a «virtual laboratory», forms the information and communication competencies of students and competencies in the field of independent, cognitive activities, as well as the implementation of a system and practical approach to training (Tarapata, 2020).

By performing correctly designed virtual laboratory work in robotics, students, firstly, develop skills in solving computational problems on this topic, secondly, approve the algorithm and technique for conducting a robotic experiment, and thirdly, study the regularities of the course of robotic processes actively involved in the educational process. The main goal of using the virtual laboratory as the use of information technologies is to achieve a new quality of education, provide methodological support for the educational process using modern, mainly interactive means and forms of training, as well as increase the educational independence and creative activity of students. Thus, part of the success of the strategy of introducing effective e-education using virtual laboratories that contribute to the independent work of students is considered a computer product (Eguchi, 2021).

A virtual laboratory is a software and hardware complex that allows experiments to be carried out without direct contact with specific equipment. In the first case, we are engaged in a remotely available laboratory installation, which includes a specific laboratory, software for controlling the installation and digitizing the data received and communication means. In the second case, all processes are modeled using a computer. Virtual labs have several advantages over specific labs:

- Today everyone knows that robotics is expensive. In addition, due to insufficient funding, many laboratories have installed old equipment that distorts the results of the experiment and may pose a potential risk to students. In addition, in industries such as chemistry, in addition to equipment, consumables (reagents) are needed, the cost of which is very high. Of course, computer equipment and software are also not cheap, but the versatility of computer equipment and its widespread use compensate for this drawback.

- When conducting laboratory work in areas such as physics, chemistry, and

robotics, dangerous experiments can pose a danger to students. And in virtual laboratories, everything is built on a special platform, so it is safe for students.

- Since the computer is engaged in controlling the virtual process, it is possible to quickly conduct several experiments with different values of input parameters, which is often necessary to determine the dependence of output parameters on input parameters.

The term "virtual laboratories" means that laboratory work and experiments in the framework of the study of primary and basic school natural science disciplines can be performed in a virtual environment. Virtual laboratories have many kinds often used in teaching physics, chemistry, and biology.

Virtual laboratories are also used in teaching computer science, but there are few of them. Virtual laboratories in computer science are often used in the robotics department.

Virtual robotics is a technology that can be used in classes in schools and in technical creative associations as an alternative to classes using robotic designers.

The relevance of this area is very high due to the high rating of educational designers, which currently can only be obtained by developing regional centers. In small towns and villages, it is impossible to purchase even minimal basic kits. But almost all rural schools have computer classrooms, and most importantly, students have computers at home. To engage in virtual robotics, it is enough to have a computer with a software package, part of which does not require the purchase of a license, and for another part the license is tens of times cheaper than that of physical robots, and never requires additional costs for repairing worn-out parts (Zaurova, et al, 2023).

The purpose of the study of the use of virtual laboratories in robotics training is multifaceted and is aimed at solving several key problems. They are:

• Accessibility and inclusivity: May evaluate the potential of virtual labs to contribute to increased access to knowledge in robotics, especially in low-income or remote educational settings where resources for physical robots may be limited.

• Safety and risk minimization: Investigating how virtual labs can provide a safe learning environment associated with student damage or trauma, including robotics.

• Cost-effectiveness: analysis of the economic feasibility of using virtual laboratories in robotics training, taking into account savings in possible costs compared to robots.

• Learning outcomes: Measuring and comparing the learning and learning outcomes of primary school students familiar with robotics concepts through virtual laboratories versus traditional methods.

• Participation and motivation: studying the influence of virtual laboratories on the participation, motivation, and interest of students in robotics.

• Curriculum development: Contribution to the development of a robotics curriculum adapted for primary school students and designed specifically for virtual laboratories.

• Robotic Education Perspectives: Understanding how virtual labs can shape the future of robotic education for primary school students, helping educators

and policymakers make informed decisions about integrating technology into the learning process.

By addressing these challenges, learners need to address the potential benefits and challenges of using virtual labs in robotics training and provide practical guidance to teachers and education stakeholders.

All subject courses are now taught in schools in various formats, the new material focuses on interdisciplinary interaction. All means of information are used, a virtual laboratory is used, and computer science courses are being developed. Using a virtual laboratory, teachers of various educational institutions can conduct training in such a way that it is easy for students to understand. A new education system is being developed to enter the global information education market. One way to improve the economic and social situation of society is to update the curriculum. This should guarantee everyone's right to self-determination and contribute to creating the necessary conditions for its implementation. Consequently, one of the main tasks of the educational institution is to create excellent learning conditions that guarantee the qualitative development of the complex education system by students, as well as its development. The existing educational process is impossible without electronic resources. Recently, new pedagogical software tools have been added to their types and composition, such as computer modeling tools, Internet sites, programs, electronic textbooks, and other educational resou rces.

Virtual laboratories are used to facilitate the training of robotics by various pedagogical methods, the creation of training programs, and the integration of educational technologies (Potkonjak, et al, 2016).

Given the value of virtual laboratories in robotics education, consider the development of laboratory laboratories for the Internet through various online platforms. For this, the platforms Open Roberta Lab, TinkerCAD, Lego Digital Designer, and Vex code VR were chosen. The educational process is well underway thanks to the help of modern media; with a ready-made virtual lab, you can help learners complete situational tasks and save time.

Digitalization is based on the goals of increasing the competitiveness of people, accelerating the educational process, increasing the standard of living of mankind, and relieving the burden on parents, teachers, and children. Raising the level of knowledge is the most important thing. Learners need to be globally competitive across different sectors, such as big data production and artificial intelligence. The virtual laboratory increases interest and awakens the interest of students in the subject, saving time to prepare for classes. First of all, before teaching students to design and manage LEGO in the real world, it is important to get a general idea of the online robotics laboratory. Now let's pay attention to the most convenient pharmacies available on the Internet, the description of the services of virtual robotic laboratories is analyzed in Figure 1 (Ajtbenova, 2023).

Vex code VR. He is exploring the possibility of using virtual robotic emulators as a training platform in solving problems related to the study of robotics in distance learning. VEXcode VR is an encoding environment that supports block and text

coding for controlling a VR robot in various virtual environments. VEXcode VR is widely available as a web application that does not require the installation of any software or additional modules. The VR robot works on unique playgrounds, which allows you to quickly encode and solve feedback problems for repairing a project.

TinkerCAD is an online service owned by Autodesk - the world's most popular CAD system. Tinkercad has long been known as a simple and free environment for teaching 3D modeling. With it, you can easily create models and send them to 3D printing. Tinkercad recently got the ability to create electronic circuits and connect them to the Arduino board virtual simulator. Important and powerful tools allow Arduino developers to greatly simplify the training, design, and programming of new schemes. Benefits of Tinkercad:

- To work on an online platform, nothing is required except a browser and a permanent Internet.
- Convenient graphic editor for visual construction of electronic diagrams.
- A set of pre-installed models of many popular electronic components, sorted by type of components.
- Simulators of sensors and external means. Sensor readings can be changed by observing how the system affects them.
- Built-in Arduino editor with port monitor and step-by-step repair.
- Ready to host Arduino projects with diagrams and codes.

The Open Roberta lab project is part of the Roberta-Learning with Robots initiative of the German Fraunhofer research organization, which unites many scientific institutions in Germany. In more than 10 years, the initiative has enabled children to study the world of robots and study computer science, science, and technology. The goal of Open Roberta is to overcome technical and professional barriers for teachers and students. Open Roberta Lab is a cloud platform that allows you to use it at any time and from any device with a browser and Internet connection. Today, only LEGO Mindstorms EV3 robots can be programmed here. Programming is graphical, allowing beginners to begin programming. The graphics programming language is called NEPO.

Gazebo is software running in a robot operating system environment that allows you to simulate and simulate robotic systems surrounded by virtual objects with sensors available in them. The program includes several components, for example: the object interaction simulation section allows you to create robotic workflows in both virtual space and graphics, which uses data obtained from virtual sensors. When working with Gazebo, you need to know the C++ language and Unix systems.

The Gazebo simulator has a built-in 3D editor that allows a simple user without programming skills to simulate processes. In addition, the Gazebo library is filled with various models of virtual robots, sensors, and objects.

Lego Digital Designer is a free program that creates 3D models from LEGO design parts. Work results can be exported in various formats and used in other 3D editors. After you create a model, the software automatically creates an assembly diagram. The LEGO Digital Designer program first appeared in 2004, but had a

slightly different purpose - it was intended to create and order a client a separate version of the design kit and later became only a virtual design program. The main advantages of the designer are:

• a rich library of templates and finished parts;
• qualitative diagram of the graphic component;
• Low level of system requirements
• A user-friendly and easy-to-learn interface
• with an integrated work foreman working at the main stages;
• Normal model-building logic
• The possibility of a presentation reflecting the workflow from the beginning to the end of the project (in an accelerated mode).

LEGO virtual robot modeling centers: Robot Virtual Worlds, Virtual Robotics Toolkit and CoderZ. Robot Virtual Worlds is a professional modeling environment that allows students to learn technical programming without robots (Ualihanova, et al, 2022).

Robot Virtual Worlds mimics the real world of 3D for LEGO robots, which allows you to use the same programming languages as robots. This program is ideal for preparing for homework, audience and competition. The disadvantage of the Robot Virtual Worlds environment is that it allows only robots created by developers to be used, and there are very few of them, the robot cannot change or add anything. If you don't have robotic designers, but you want to control your design models, then the best solution is Virtual Robotics Toolkit - it's a modeling environment, a virtual world where you can place a LEGO robot model. The actions of the virtual model are completely true and can be transferred to a specific robot unchanged when the program written for the virtual model repeats all actions of the virtual model. It will also make it possible to prepare children for competitions in the absence of expensive equipment. Features of the Virtual Robotics Toolkit include:

● EV3 software is required;
● runs on Mac OS X or Windows;
● a wide range of virtual centers such as FLL and WRO;
● imports free robot samples such as LEGO Digital Designer;
● Promotes cooperation through the exchange of examples of virtual robots and codes;
● An adjustable physics engine allows you to study physical forces such as friction, and gravity (Ualihanova et al, 2022).

CoderZ is an online program developed by the Israeli company RoboGroup that trains children to program virtual and 3D robots. It does not require installation or expensive equipment, making it accessible to children in all schools. An online learning environment that allows learners to learn the block programming language and programming by simulating a virtual 3D robot.

It has been created with several game missions involving more than 15 hours of curricula, activities, and assignments. Opportunities include:

● Block coding;

- Works in a browser, so installation is not required;
- Consists of a series of guided missions;
- Teachers can create classrooms and monitor student performance;
- Classes offer a virtual competitive online coding tournament.

Robot Virtual Worlds (the virtual world of robots) is a professional modeling environment that allows students to learn how to program without robots. The author's experience shows that learning to program in this environment using specific physical robots is more effective than in lessons. Robot Virtual Worlds models the real world of 3D for LEGO robots, which allow programming languages such as physical robots. This program is very convenient for doing homework, and preparing for cool events and competitions.

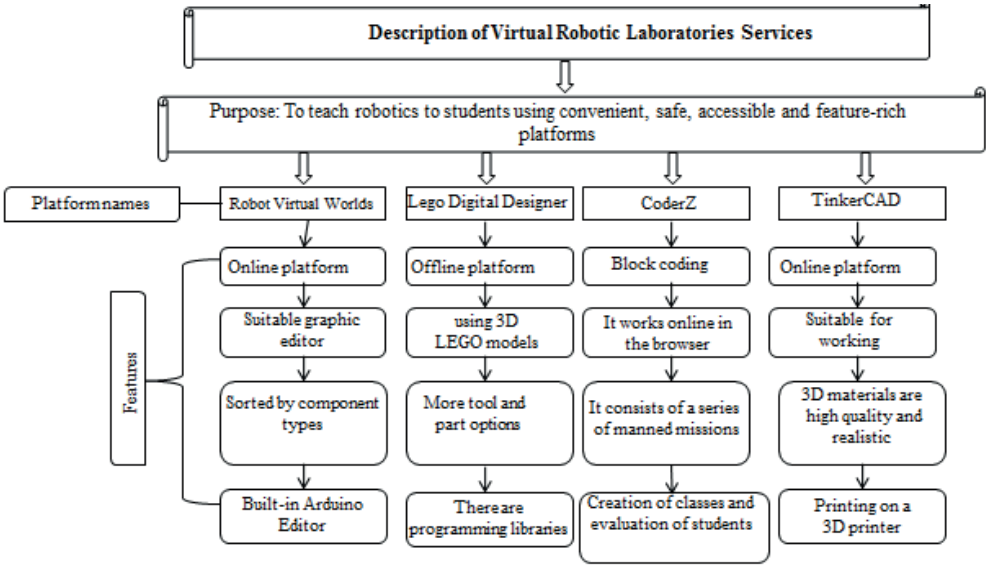

Figure 1 - Description of virtual robotic laboratory services

For example, consider the task of turning on traffic lights using Arduino in a TinkerCad virtual lab environment. This task runs a traffic light with red, orange, and green lights. The traffic light was originally lit in red. And green burning lasts 5 seconds and takes 2 seconds to go from red to green, that is, orange.

First, we connect all the components, as shown in Figure 2. Click on the LEDs to find a small pop-up where you can change the color of the LEDs. We change the colors in accordance with the task. We can select and list the necessary components of the model: Arduino Uno R3-1 pcs.; 1 pc., made of red light-emitting diode; 1 pc., of orange light emitting diodes; 1 pc. 100 Ω resistor - 3 pcs.

Results and discussion. We continue the pins according to each color. Red light LED up to 7 pins (LED anode); we bring 6 orange pins. Connect all cathodes to green and GND to pin 5. Now let's write him a code. Per the demonstration declaration, we install various LEDs. First, add a red lantern (pin2 - above). Then wait 5 seconds.

Extinguish the red lamp (below pin-5). Add an orange LED (pin 6 - above). Wait 2 seconds. Turn off the orange LED (pin-6- down). Turn on the green LED (pin 5- above). Wait 5 seconds. Turn off the green LED (pin 7 down) and try again. The works in Figure 2 have been performed under this contract. The execution of these actions is reflected in the following code and flowchart (Figure 3).

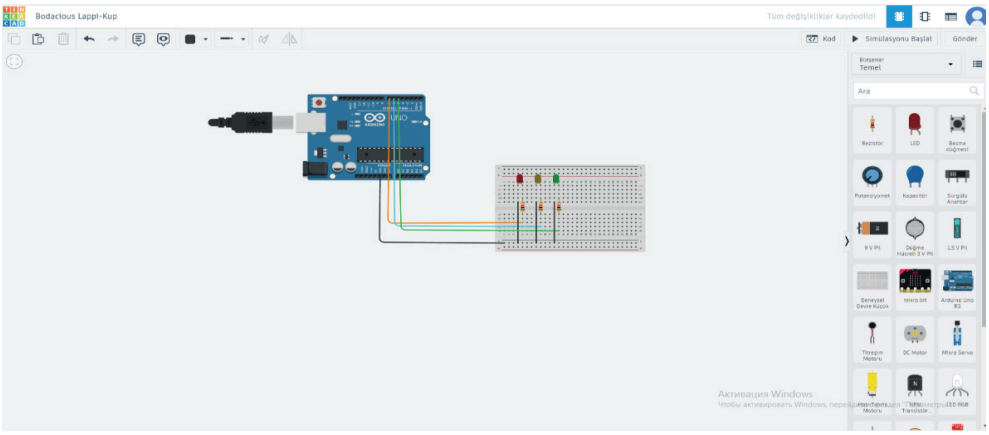

Figure 2 - Task for ignition of traffic lights colors

```
int red = 7 ;//7 corresponds to the pin of red
int yellow = 6 ;//6 corresponds to an orange pin
int green = 5 ;//5 corresponds to a green pin
void setup()
{
Outputs pinMode (red, OUTPUT) ;//red
Outputs pinMode (yellow, OUTPUT) ;//orange
Outputs pinMode (green, OUTPUT) ;//green
}
void loop()
{
digitalWrite (red, HIGH) ;//red lights up
digitalWrite (yellow, LOW) ;//orange
digitalWrite (green, LOW) ;//green
delay (5000) ;//red lights up 5 seconds apart
digitalWrite (red, HIGH) ;//applies red
digitalWrite (yellow, HIGH) ;//lit in orange
digitalWrite (green, LOW) ;//green
delay (2000); red and yellow 2 seconds apart
digitalWrite (red, LOW) ;//red
digitalWrite (yellow, LOW) ;//orange
digitalWrite (green, HIGH) ;//green
delay (5000) ;//green lights up 5 seconds apart}
```

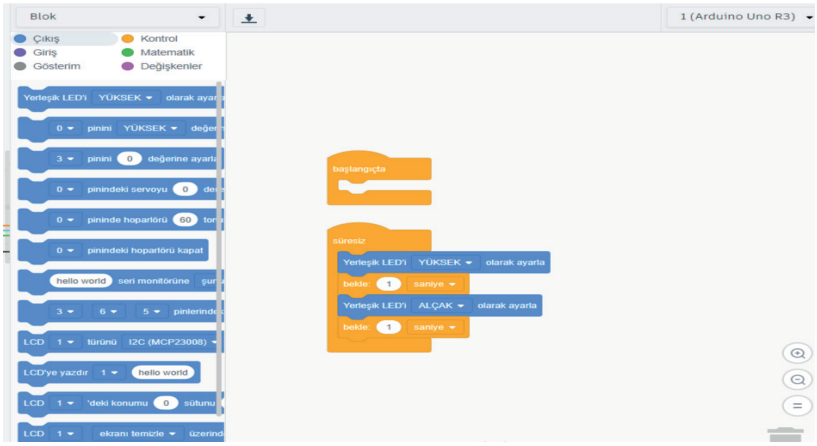

Figure 3 - Block diagram of the task of burning traffic light colors

The creators of this environment will provide detailed methodological materials for its introduction into the educational process. A detailed curriculum for teaching programming in the virtual world was presented. Virtual world training tasks are available in the robotic text programming environment and in the LEGO graphics programming environment using the NXT virtual control unit emulation program.

Competition venues are designed to train, prepare for robotics competitions and temper their skills. There are more than 50 sites that allow you to check and explore programs written for the robot.

Additional means facilitate the adaptation of the environment to certain educational or competitive tasks. The site editor allows you to create your tasks, for example, a specific path that the robot must overcome. The object import tool will help the robot perform certain actions (sorting, collision, transfer) and add various obstacles or "goals" to the path. The NXT control unit emulator allows you to program a virtual robot in the same way as a real robot, which uses the local LEGO graphics programming environment of NXT robots or a newer program for EV3 third-generation LEGO robots.

The main feature of the environment is that game worlds must use programming skills to learn fantastic worlds using robots. There are 4 fantastic game worlds (Palm Island, Atlantis Expedition, Operation Reset, and the ruins of Atlantis). They allow you not only to learn programming, but also to use proportions to calculate the motion of the robot, so they can be used in integrated mathematics lessons when studying proportions. Although these games are no different from ordinary ones, in fact the student cannot control the robot directly (from the keyboard), but for each action of the robot he must write program code. Writing code in Robotic is no different from programming specific robots by specialists in factories.

If you don't have robotic designers, but you want to manage your development models, then the best solution - a program for virtual robotic tools - is modeling, a virtual world on which you can place our model of a robot from LEGO Digital

Designer and work with it. The behavior of the virtual model is completely consistent with the specific model, and the program for the virtual model can be changed to a specific robot, repeating all the actions of the virtual model. Virtual Robotics Toolkit simulates interacting game rooms and their environments, allowing full exploration of all aspects of robotics. There is a level editor that allows you to create virtual copies of competitive fields and objects on them. This will allow children to be trained and prepared to compete without expensive equipment or to be given homework.

Now we note the advantages and disadvantages of simulators. Advantages: low cost, the ability to have unlimited models, and the ability to model several types of robots at the same time. Disadvantages: increasing the time spent working with a computer, even the best physical model cannot simulate all the laws of the real world.

Virtual laboratories cover various aspects, such as curriculum development, teaching methods, learning outcomes, student participation, and the development of fundamental knowledge and skills in robotics. Researchers will explore how to integrate virtual labs into the education system to improve the educational process and ensure that primary school students understand the complex concepts of robotics in a secure and interactive digital environment. The study aims to understand the benefits and difficulties of this approach and educate young students about improving robotics education.

Use of virtual laboratories in teaching: the equipment used in real laboratories allows you to conduct experiments with equipment, acquire practical skills of students, and get acquainted with pedagogical tools. The virtual laboratory is considered from a didactic point of view as a method, a means of teaching for teachers and students.

Since Tinker Cad is a platform that allows full-fledged laboratory work due to the fact that it is publicly available, easy to use and some platforms are free, design and systems programming is carried out in the Tinker Cad environment.

Despite the advantages of these virtual laboratory environments in learning practices, there is no specially designed laboratory work methodology. With this issue in mind, research work was carried out. In order to determine the relevance of virtual laboratory work, level tasks in online form in the course of teaching robotics, a survey of teachers teaching in higher educational institutions of the country was conducted. The survey was conducted online, using the Google Form environment, where the confidentiality of the participants was maintained for authenticity and accurate answers. 40 people took part in the survey. The list of questions in the questionnaire is shown in Table 1 below.

Table 1. Content of the survey of university teachers

№	Survey question	Yes	No	I find it difficult to answer
1	Do you want to use digital educational tools in teaching?	36	2	2
2	Do you use virtual labs in robotics classes?	33	7	
3	Do you find it useful for students to have virtual labs for classes?	38	1	1
4	Will virtual laboratories provide a solution as a simulation of robotic modeling and assembly?	32	6	2

5	Are you satisfied with the students performance of the task in the lesson?	29	6	5
6	How is your approach to teamwork? Support?	38		2
7	Do you like to spend time in class without using a virtual laboratory when there is no robot equipment?		40	
8	Do you like to spend time in class without using a virtual laboratory when there is no robot equipment?	39	1	

In total, the questionnaire from teachers of robotics at the University contained 8 questions. The survey asked for support and non-support in order to find out the opinions "the need for virtual laboratory use in robotics classes". As can be seen in Table 1, the majority of teachers expressed their support (Figure-3). The reason for the support is explained by the lack of equipment in the implementation of laboratory work in teaching robotics. As a result of the study, only 1 teacher said that in the lesson the Robot should hold the tools with his hands and see them with his eyes.

The diagram of the results of the questionnaire for university teachers "the need to use a virtual laboratory in robotics lessons" is shown in Figure 4.

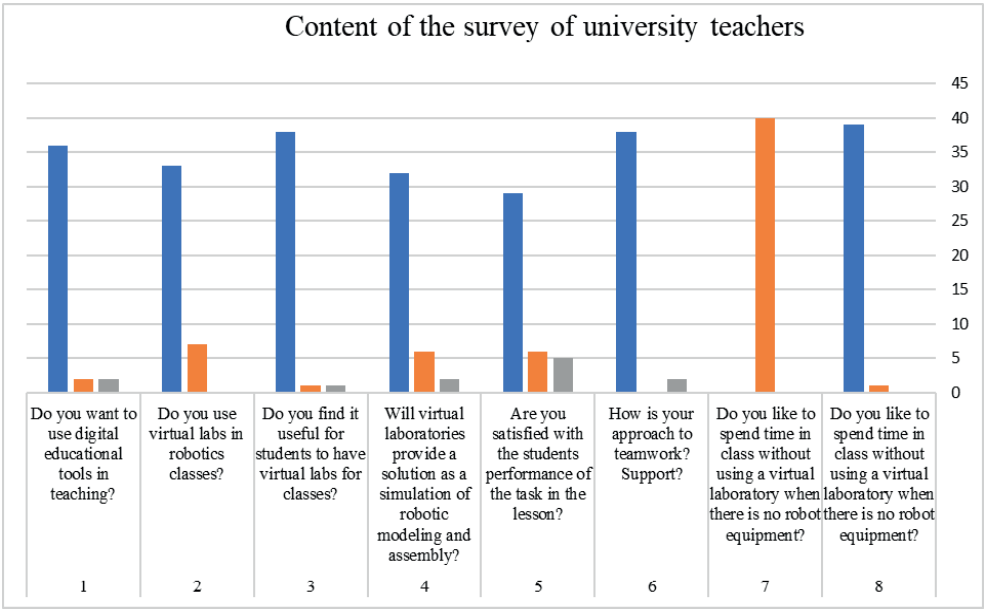

Figure 4 - The result of the survey of university teachers “The need to use a virtual laboratory in robotics lessons”

The results of the conducted research were visually presented using the data in Table 1 and the diagram in Figure 4 by observing the results. The results obtained during the survey allow us to draw the following conclusions: having identified the possibilities of virtual laboratories, the need for their application in higher education was determined. It was determined that the results of training in robotics disciplines will increase through the use of virtual laboratories.

The purpose of modern training is comprehensive, comprehensive training, education, and development of students. The dynamic and interactive nature of virtual laboratories contributes to the development of students' creative abilities and task-solving skills.

After analyzing the given definitions, data, in the framework of the study, using virtual robotics and teaching robotic tools, the virtual environment is considered as a pedagogical tool in which teaching and learning materials are attractive, effective, and productive. Virtual Secondary Education offers an alternative that breaks many of these barriers, providing students with a safe and cost-effective environment in which they can learn the principles of robotics. The" Tinker Cad " environment is designed to be suitable for real and various robotic tasks using a modeling environment for various robotic structures. There is an opportunity to work in a virtual environment without equipment, for this it is enough to have only a computer and the internet. As a result, students will be able to learn how to assemble a robot and program a robot and apply the acquired knowledge in practice.

Conclusions. In conclusion, integrating virtual labs into robotics training is a key step in education. Connecting virtual laboratories to educational tools will not only improve the educational experience but also solve important problems of traditional education in the field of robotics, as it pays attention to the constantly changing technological landscape. The interesting nature of virtual laboratories allows learners to participate in practical experiments and simulations, contributing to a deeper understanding of the complex concepts of robotics.

In addition, virtual labs provide massive, cost-effective solutions to physical lab problems, providing access to advanced hardware and scenarios without limiting time and resources. Such democratization of educational resources is very important in the context of robotics, where access to specific equipment and the environment may be limited.

In addition, the dynamic and interactive nature of virtual laboratories contributes to the development of students' creativity and problem-solving skills. The ability to experiment with different scenarios, change parameters, and track results in real time allows students to learn the details of robotics both in a controlled and real environment. This not only prepares them for the challenges of the booming robotics industry but also nurtures a desire for adaptation and innovation.

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